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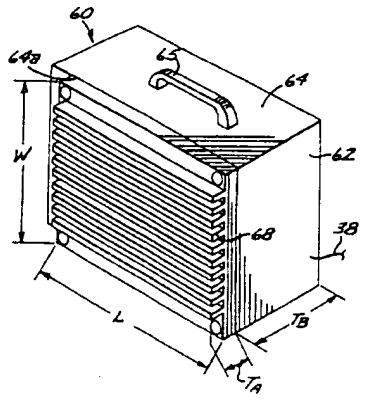
(54) Integrated flat antenna and radio frequency unit for point-to-point microwave radio communications

(57) A point-to-point integrated radio frequency unit/antenna (60) has a flat antenna (68), preferably a continuous transverse stub antenna (68), integrated into the housing (62) of the microwave unit (60). The radio frequency unit/antenna (60) includes a housing (62) having an exterior wall (64), a microwave radio frequency transceiver electronics package (66) within the housing (62) and having an antenna connection (46), and a flat antenna (68) affixed to one face of the exterior wall (64) of the housing (62). A microwave radio frequency feed (48) communicates between the flat antenna (68) and the antenna connection (46) of the microwave transceiver electronics package (66). There is preferably a bracket structure (88) on another face of the housing (62) to affix the housing (62) to a support (86).

FIG. 3



EP 0 814 538 A1

Description

BACKGROUND OF THE INVENTION

This invention relates to microwave radios, and, more particularly, to a radio frequency unit for a microwave radio.

Microwave radio communications are widely used to transfer large amounts of data, such as in earth and space microwave long-distance communications links. They are also of interest for shorter-range, lower-power applications such as the basic voice, video, and data links between, for example, a cellular base station and the central telephone office. In such applications, the microwave transmission distance is typically between about 0.805-8.05 km [0.5-5 miles], the microwave signal may be a specific frequency between about 2-94 GHz, and the power output of the microwave transmitter is about 100 milliwatts. Such microwave communications system are generally termed "point-to-point" systems.

Corresponding to the high-power microwave communications systems, a conventional point-to-point system has three basic physical parts: a signal processing unit (SPU), sometimes termed an "indoor" unit having the baseband radio components, a radio frequency (RF) unit (RFU), sometimes termed an "outdoor" unit having the microwave frequency radio components, and an antenna. Because a microwave feed is required between the components operating at microwave frequency, the radio frequency unit is located within a few feet of the antenna, which ordinarily is mounted outside and aimed at another point-to-point terminal located some distance away. The antenna is typically a parabolic antenna of the cassegrain type. The signal processing unit may be located quite some distance from the radio frequency unit. An ordinary cable set extends between the signal processing unit and the radio frequency unit, but a microwave coaxial feed is required between the radio frequency unit and the antenna.

As point-to-point systems become more popular, their physical packaging becomes more important. The existing radio frequency units and antennas are bulky and, in many cases, difficult to mount, align, and maintain in alignment. With the proliferation of point-to-point systems in large cities, new mounting space on existing masts and elsewhere has become more difficult to find. Installers must hoist the subsequently installed radio frequency unit and antenna to ever-more-precarious locations in order to establish line-of-sight contact with the remote terminal. Conventional point-to-point radio frequency units and antennas may be obtrusive and unsightly, particularly when large numbers of them are concentrated in the available space.

There is a need for an improved radio frequency unit and antenna which overcomes these problems. The present invention fulfills this need, and further provides related advantages.

SUMMARY OF THE INVENTION

The present invention provides an integrated point-to-point microwave radio frequency unit/antenna. The integrated radio frequency unit/antenna is compact and lighter than existing units, easily handled and mounted, and readily aligned and maintained in alignment. It can be mounted in locations which would not be practical for conventional microwave radio frequency units and antennas, such as windows of office buildings. The installer need be concerned with only a single box, not two separate components with a microwave cable extending between them, as is the case for some existing systems. The flat-plate, integrated radio frequency unit/antenna is consequently much less visually obtrusive than conventional systems using a parabolic dish antenna.

In accordance with the invention, an integrated point-to-point microwave radio frequency unit/antenna comprises a housing having an exterior wall, a microwave radio frequency transceiver electronics package within the housing and having an antenna connection, a flat antenna integral with the exterior wall of the housing, and a microwave radio frequency feed communicating between the flat antenna and the antenna connection of the microwave transceiver electronics package. There is desirably a means such as a bracket structure built into another wall of the housing to affix the housing to a support structure.

The flat antenna is preferably a continuous transverse stub antenna that is rectangular in shape and relatively thin. It may built into the side of the housing as part of the wall, or more preferably, built as a separate unit and attached integrally to the wall of the housing. The required size of the antenna is dependent upon the frequency at which it is used. For example, such a flat antenna with 38 dB of gain when used for transceiving at 38 GHz is typically 26.67 by 26.67 cm [10-1/2 inches by 10-1/2 inches] in transverse extent, the square antenna being a special case of the rectangular antenna, and about 2.54 cm [1 inch] thick. The housing, including all of the electronics package, is typically about 30.5 by 30.5 cm [12 inches by 12 inches] in transverse dimensions, and about 7.6 cm [3 inches] thick. The entire radio frequency unit/antenna is thus no larger than a small cosmetics case. It is easily handled, mounted, and aimed. By contrast, a conventional radio frequency unit itself has a size of about 30.5 by 30.5 by 30.5 cm [12 inches by 12 inches by 12 inches], and the associated parabolic antenna has a diameter of 30.5-61 cm [12-24 inches].

The approach of the invention also offers electronic features not possible with a conventional approach. The microwave feed between the electronics package and the antenna is on the order of at most a few inches and is inside the housing, reducing the possibility of damage or interference. The preferred continuous transverse stub flat antenna may be electronically aimed to achieve line adjustment of the alignment and to maintain align-

ment when mounting conditions change, such as when a mounting mast sways or a building deforms due to thermal effects during the course of a day.

Other features and advantages of the present invention will be apparent from the following more detailed description of the preferred embodiment, taken in conjunction with the accompanying drawings, which illustrate, by way of example, the principles of the invention. The scope of the invention is not, however, limited to this preferred embodiment.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is a schematic diagram of a microwave radio transmitter and receiver;
Figure 2 is a perspective view of a conventional microwave radio frequency unit and antenna;
Figure 3 is a perspective view of an integrated radio frequency unit/antenna according to the invention;
Figure 4 is a partially sectioned front elevational view of an preferred integrated radio frequency unit/antenna according to the invention;
Figure 5 is an exploded side elevational view of the integrated radio frequency unit/antenna of Figure 4, illustrating a typical layout of components; and
Figure 6 is a schematic perspective view of a conventional radio frequency unit and antenna and an integrated radio frequency unit/antenna mounted to a mast.

DETAILED DESCRIPTION OF THE INVENTION

Figure 1 is a schematic diagram of a microwave radio transceiver system 20. The general electronic structure of such systems 20 is known in the art and is described in greater detail, for example, in "RF Components for PCS Base Stations", published by Strategies Unlimited, 1996. The present invention resides not in a change to this basic, known electronic approach, but in its packaging and presentation in a highly advantageous form.

The system 20 includes a signal processing unit 22 that processes baseband signals, an radio frequency unit 24 that processes microwave signals, and a microwave antenna 26. The signal processing unit has as one input/output voice, video, and/or data link information 28. This information 28 is processed through a baseband circuitry 30 and a modulator/demodulator 32. A controller 34 and a power supply 36 are also provided. The signal processing Unit 22 communicates with the radio frequency unit 24 at low frequencies through a conventional signal cable 38.

The radio frequency unit 24 includes a microwave transceiver 40 that operates in a selected microwave frequency band within the broad band extending from about 2 to about 94 GHz (Gigahertz) by converting the low-frequency signal of the signal processing unit 22. A controller 42 and a power supply are provided. The microwave transceiver 40 has an antenna connection 46 into which a microwave radio frequency feed 48 is connected to provide a signal to the antenna 26, or to receive a signal from the antenna. The feed 48 may be a coaxial cable or waveguide which cannot be more than a few feet long without suffering substantial signal attenuation.

Figure 2 depicts the implementation of a conventional prior radio frequency unit 24 and antenna 26, connected by the microwave feed 48, which utilizes the electronics approach of Figure 1. The radio frequency unit 24 typically has measurements of 30.5 by 30.5 by 30.5 cm [12 inches by 12 inches by 12 inches] and weighs about 15.88 kg [35 pounds]. The antenna 26 is a cassegrain parabolic antenna having a dish diameter of about 30.5 cm [12 inches] or more and a weight of about 6.80 kg [15 pounds].

Both components must be mounted at a location such that the antenna 26 may be aimed at a similar but remotely located terminal. The installer must find a way to mount the antenna 26 so that it is aligned with the antenna of the remote unit, and to mount the radio frequency unit 24 so that it is secure yet is within the range permitted by the length of the microwave feed 48. Other versions of the prior approach of Figure 2 are known wherein the parabolic antenna is affixed directly to the radio frequency unit, but such a combined approach remains awkward to handle and heavy.

Figure 3 shows an integrated radio frequency unit/antenna in perspective view. Figure 4 illustrates a preferred form of the present invention in partially sectioned front elevational exterior view, and Figure 5 is an exploded side view of the preferred apparatus. This apparatus uses the general electronics approach of Figure 1, but with a different architecture and antenna that offers important advantages. An integrated radio frequency unit/antenna 60 includes a housing 62 having an exterior wall 64. A handle 65 extending from the housing 62 permits the radio frequency unit/antenna 60 to be easily carried. A microwave radio frequency transceiver electronics package 66 is fixed in the housing 62. The electronics package 66 includes the microwave transceiver 40, the controller 42, and the power supply 44. Part of the exterior wall 64 is formed as an integral flat antenna 68. The flat antenna 68 may be formed separately and attached to the wall 64, as illustrated, or it may be formed as part of the wall itself. That portion of the wall 64 which is not the antenna 68 may be made of any operable material, such as a metal or a plastic. A radome 70 in the form of a plastic sheet is mounted over the face of the flat antenna 68 to protect it.

The flat antenna 68 is preferably a continuous transverse stub (CTS) antenna. The CTS microwave antenna is known in the art and is described, for example, in US Patent 5,266,961, whose disclosure is incorporated by reference. In general terms, and as illustrated in Figures 3 and 5, the CTS antenna has a dielectric element with a first portion and a second portion extending generally transversely to the first portion. The second portion forms a transverse stub that pro-

trudes from a first surface of the first portion. A first conductive element is disposed coextensively with the dielectric element along a second surface of the first portion. A second conductive element is disposed along the first surface of the dielectric element and is along transversely extending edgewalls formed by the second portion of the dielectric element. Further detail of construction are disclosed in the '961 patent.

The CTS antenna has particular advantages when used in the present application. The CTS antenna is planar, small in lateral dimensions and thickness, and light in weight. The output signal of the CTS antenna may be steered slightly electronically. During mounting, the radio frequency unit/antenna 60 must be aligned generally toward the remote unit with which communication is established. However, that alignment may be slightly disrupted due to weather or temperature effects on the mounting structure. In that case, the small deviation from proper alignment may be compensated for electronically to maintain a high signal strength aimed at the remote unit.

The integrated radio frequency unit/antenna 60 has an antenna connection 46 and a microwave radio frequency feed cable 48 extending from the antenna connection 46 to the back side of the flat antenna 68. However, that radio frequency feed 48 is at most 2.54-5.08 cm [1-2 inches] long and contained entirely within the housing 62. There is very little microwave attenuation as the signal passes through this short feed 48. The installer is only required to position and fix in place the single integrated radio frequency unit/antenna 60, and is not concerned with moving and positioning two units in a compatible manner.

The inventors have developed a prototype design for the integrated radio frequency unit/antenna 60, shown in Figures 4-5, for operation at a microwave frequency of 37-40 GHz. The flat antenna has a width W of about 20.67 cm [10-1/2 inches], a length L of about 20.67 cm [10-1/2 inches], and a thickness T_A of about 2.54 cm [1 inch]. The remaining components, the microwave transceiver 40, controller 42, and power supply 44 fit into a housing having the same length and width, and a thickness T_B of about 5.08 cm [2 inches]. The total size of the housing and antenna package is about 30.5 cm [12 inches] by 30.5 cm [12 inches] by 7.6 cm [3 inches]. The weight of the integrated radio frequency unit/antenna 60 is about 4.54 kg [10 pounds].

Figure 6, which is schematic and not drawn to scale, illustrates the mounting of a conventional radio frequency unit 80 and its antenna 82, connected by their microwave feed 84, on a mast 86. Also shown is an integrated radio frequency unit/antenna 60 of the invention. The integrated radio frequency unit/antenna 60 has a mounting bracket 88 attached to one of the exterior wall 64 other than the one to which the integrated flat antenna 68 is attached, and the mounting bracket permits straightforward adjustable attachment to the mast 86. It is apparent that the approach of the invention is much more convenient for installation and alignment than the conventional approach. The integrated radio frequency unit/antenna 60 can also be mounted in locations and places which are largely not usable with the conventional device. For example, the integrated radio frequency unit/antenna 60 is readily mounted to a window frame in much the same manner as a room air conditioner.

Although a particular embodiment of the invention has been described in detail for purposes of illustration, various modifications and enhancements may be made without departing from the spirit and scope of the invention. Accordingly, the invention is not to be limited except as by the appended claims.

Claims

1. An integrated point-to-point microwave radio frequency unit/antenna (60) comprising:

   a housing (62) having an exterior wall (64);
   a microwave radio frequency transceiver electronics package (66) within the housing (62) and having an antenna connection (46);
   a flat antenna (68) integral with the exterior wall (64) of the housing (62); and
   a microwave radio frequency feed (48) communicating between the flat antenna (68) and the antenna connection (46) of the microwave transceiver electronics package (66).

2. The radio frequency unit/antenna of claim 1, characterized in that the electronics package (66) comprises:

   a transceiver (40) having a low-frequency side with a baseband signal connection and a high-frequency side;
   a radio frequency antenna coupler in communication with the high-frequency side of the transceiver (40) and including the antenna connection (46);
   a controller (42) for the transceiver (40); and
   a power supply (44) for that transceiver (40) and the controller (42).

3. The radio frequency unit/antenna of claim 1 or 2, characterized in that the flat antenna (68) forms a part of the exterior wall (64).

4. The radio frequency unit/antenna of claim 1 or 2, characterized in that the flat antenna (68) is affixed to the exterior wall (64).

5. The radio frequency unit/antenna of any of claims 1 to 4, characterized by means (88) for affixing the housing (62) to a support (86).

6. The radio frequency unit/antenna of any of claims 1 to 5, characterized in that the flat antenna (68) is a

continuous transverse stub antenna.

7. The radio frequency unit/antenna of claim 6, characterized in that the continuous transverse stub antenna (68) is rectangular in shape.

8. The radio frequency unit/antenna of claim 7, characterized in that the continuous stub antenna (68) has rectangular dimensions of about 26.67 cm [10-1/2 inches] wide by 26.67 cm [10-1/2 inches] long.

9. The radio frequency unit/antenna of any of claims 1 to 8, characterized in that the antenna connection (46) of the electronics package (66) has an input/output frequency of from about 2 GHz to about 94 GHz.

10. The radio frequency unit/antenna of claim 9, characterized in that the antenna connection (46) of the electronics package (66) has an input/output frequency of from about 37 GHz to about 40 GHz.

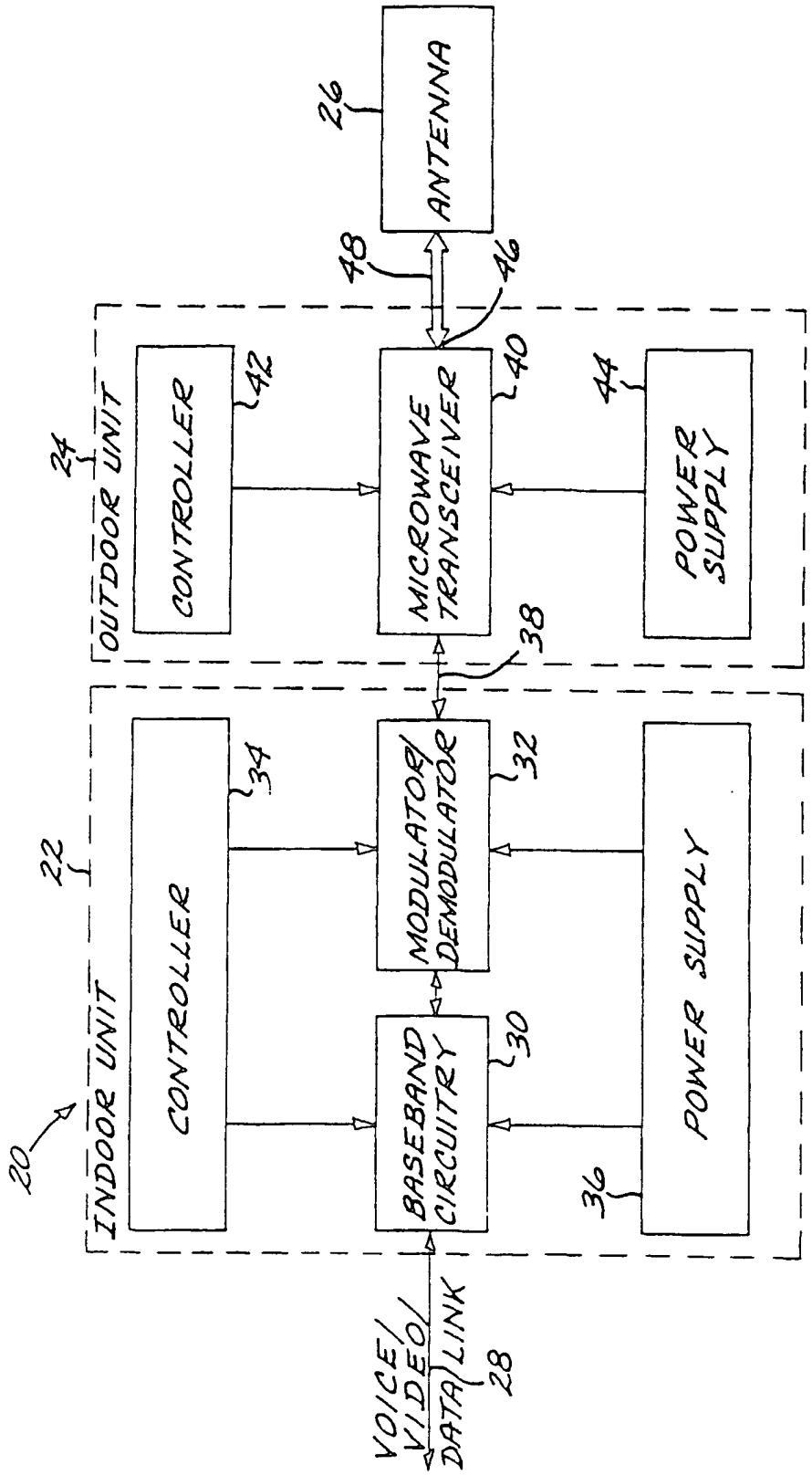

ANTENNA
26
48
46
OUTDOOR UNIT
24
CONTROLLER
42
MICROWAVE TRANSCEIVER
40
44
POWER SUPPLY
38
INDOOR UNIT
22
CONTROLLER
34
MODULATOR/ DEMODULATOR
32
BASEBAND CIRCUITRY
30
POWER SUPPLY
36
20
VOICE/ VIDEO/ DATA LINK
28

FIG. 1

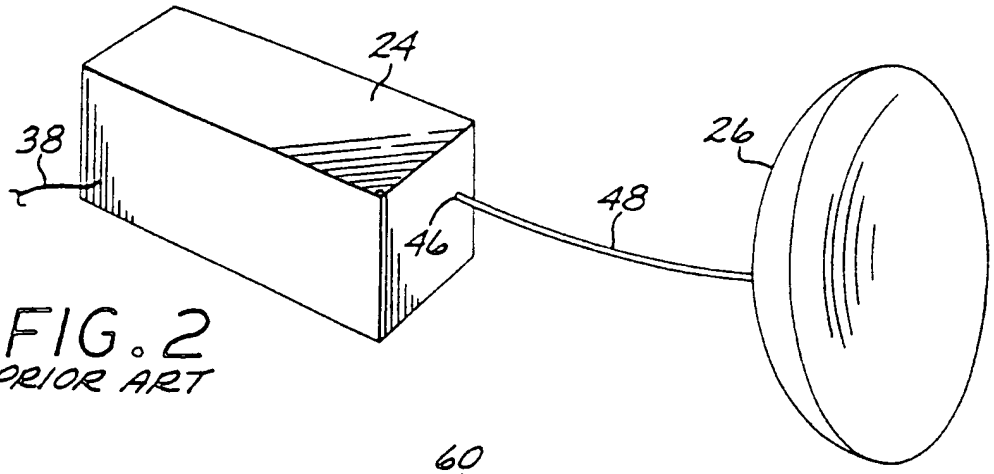


FIG. 2
PRIOR ART

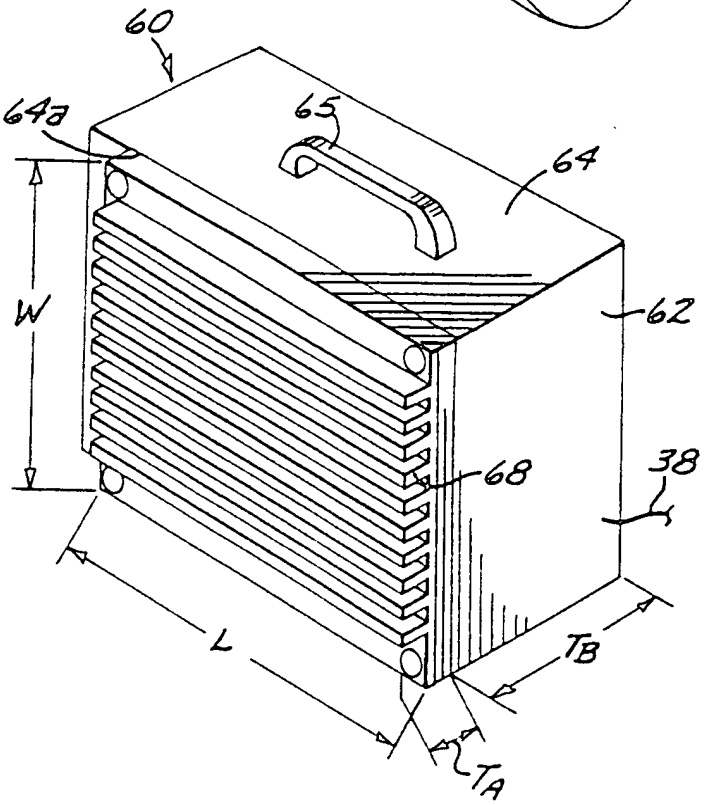


FIG. 3

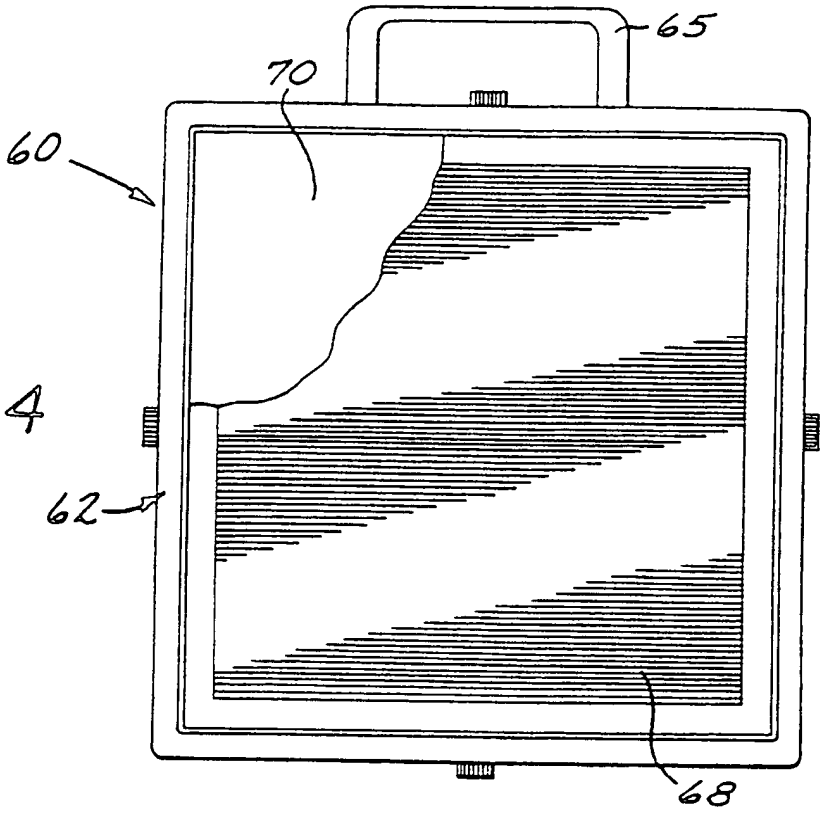


FIG. 4

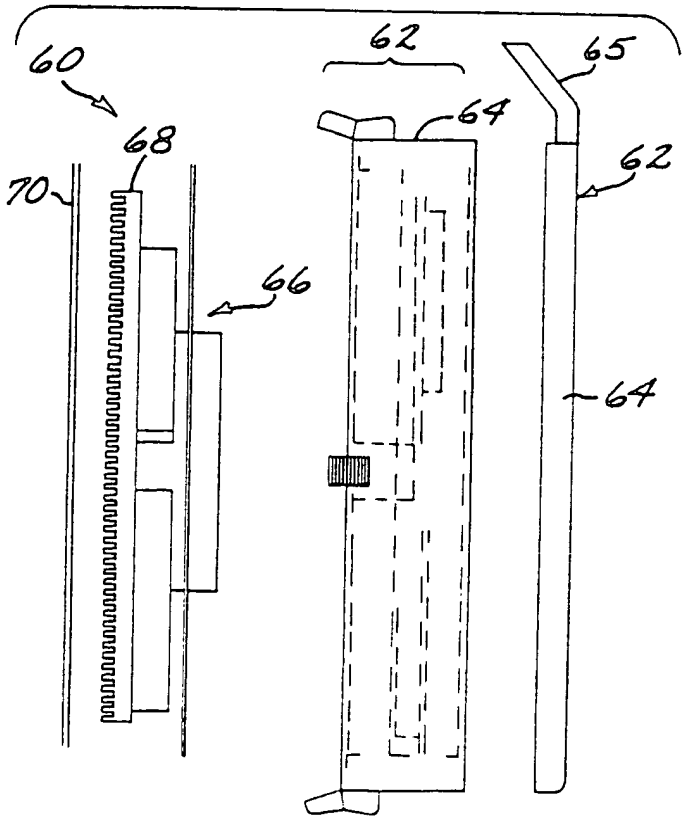


FIG. 5

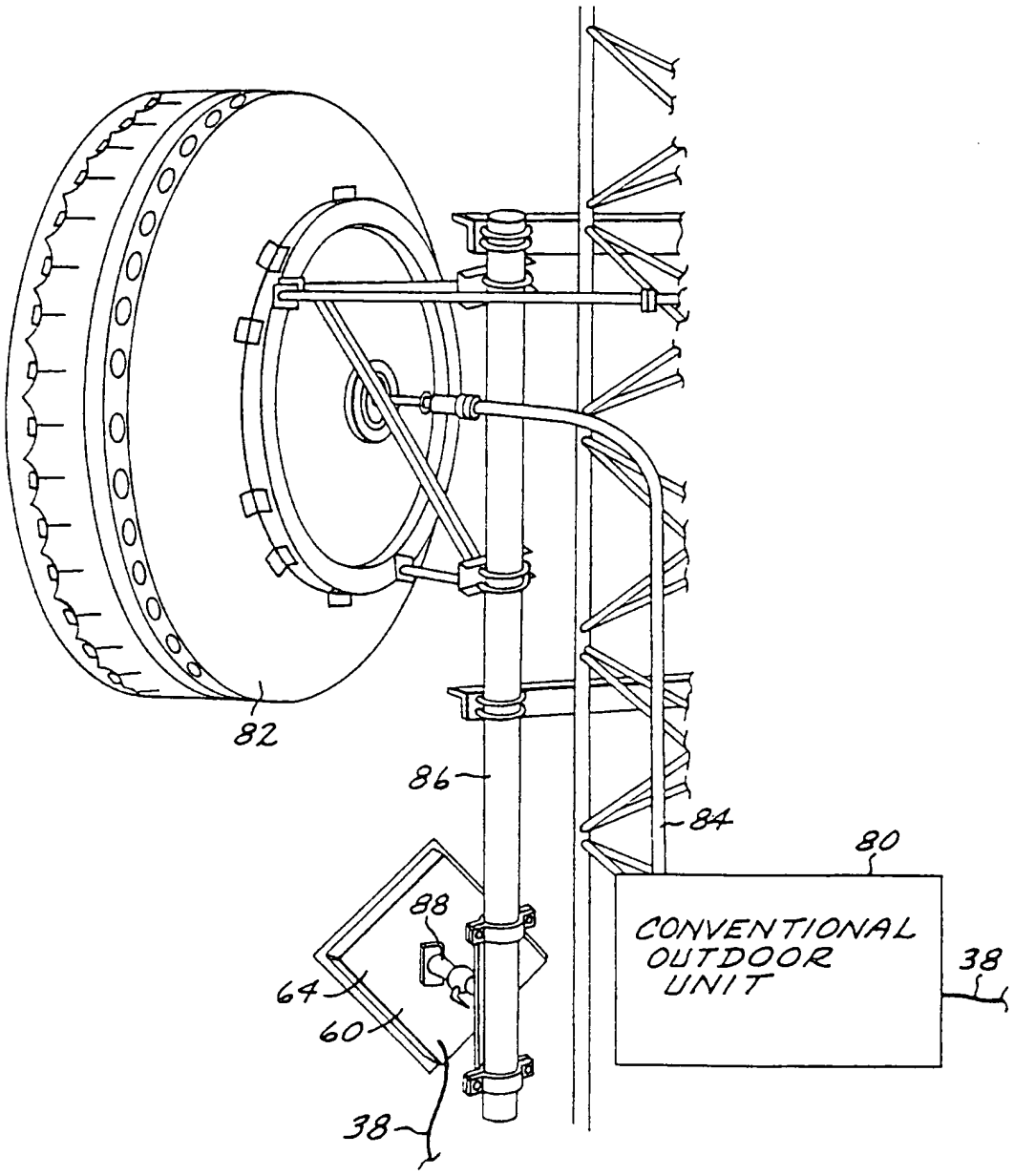


FIG. 6

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 97 10 9733

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.6)
X	EP 0 626 764 A (NIPPON ELECTRIC CO) 30 November 1994	1-5,9,10	H01Q23/00 H01Q21/06
Y	* column 2, line 6 - column 4, line 22; figures 1,2 *	6-8	

Y	US 5 266 961 A (MILROY WILLIAM W) 30 November 1993 * column 9, line 63 - column 10, line 7; figure 21 *	6,8	

X	US 5 400 039 A (ARAKI HIROSHI ET AL) 21 March 1995	1-5,9,10	
Y	* column 6, line 22 - column 9, line 49; figures 1-6 *	6,8	

X	EP 0 570 325 A (ISRAEL STATE) 18 November 1993	1-5,9,10	
Y	* column 2, line 25 - column 3, line 18; figure 1 *	6-8	

X	US 4 876 709 A (ROGERS MAX W ET AL) 24 October 1989 * column 4, line 12 - column 6, line 59; figures 1-4,7 *	1-4	TECHNICAL FIELDS SEARCHED (Int.Cl.6) H01Q

X	DE 41 28 972 A (TELEFUNKEN SYSTEMTECHNIK) 4 March 1993	1-5,9,10	
Y	* column 3, line 37 - column 5, line 11; figures 1-3 *	6-8	

X	WO 95 25387 A (FUJITSU LTD ;MINOWA YOSHIAKI (JP); KUMAHARA KAZUO (JP); HAGIWARA Y) 21 September 1995	1-5,9,10	
Y	abstract; fig. 13	6-8	

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
MUNICH	29 September 1997	Cannard, J-M

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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